

Hepatoprotective Evaluation of *Alternanthera Brasiliana* (L.) Leaf Extract against Carbon Tetrachloride-Induced Liver Fibrosis in Mice

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ABSTRACT

Liver fibrosis is a complicated and ongoing disease that happens when the liver is repeatedly injured by harmful substances like chemicals, medicines, viruses, alcohol, or metabolic problems. This injury leads to the buildup of extra materials, especially collagen, which changes the structure and function of the liver. If not treated, liver fibrosis can get worse and lead to cirrhosis, high blood pressure in the portal veins, liver failure, and liver cancer. These conditions are a big problem for global health. Even though there's a lot of research, there aren't many good medicines for liver fibrosis, and the ones that are available often have side effects and are expensive. So, there's growing interest in finding safe, effective, and affordable treatments, especially from natural sources. Oxidative stress and inflammation are key factors in the start and spread of liver fibrosis. When the liver is injured, harmful chemicals called reactive oxygen species are created, which damage cells, activate special liver cells, and increase collagen production, making fibrosis worse. Plants with chemicals that fight oxidative stress and inflammation can help protect the liver. This study tested a leaf extract from the plant *Alternanthera brasiliana* to see if it can protect and reduce fibrosis in mice that had liver fibrosis caused by carbon tetrachloride, which is a model that closely matches human liver fibrosis. The leaves of *A. brasiliana* were made into an extract using a good solvent. The extract had many useful plant compounds like flavonoids, phenols, alkaloids, saponins, triterpenoids, and glycosides, known for their ability to fight oxidative stress, reduce inflammation, and protect cells. Safety tests showed the extract was safe at the doses used, making it suitable for long-term studies. Liver fibrosis was caused by giving the mice repeated doses of carbon tetrachloride. This led to changes in blood tests, signs of oxidative stress, and liver tissue damage. The mice had high levels of enzymes like ALT, AST, and ALP, and higher bilirubin, along with lower total protein, showing serious liver damage. Oxidative stress tests showed more damage to fats and less protection from the body's natural antioxidants. Treating the mice with the *A. brasiliana* extract improved their liver function markers and brought back the body's natural enzymes that fight oxidative stress.

Keywords: ALT, AST, ALP, *Alternanthera Brasiliana*, Liver Fibrosis

INTRODUCTION

Liver fibrosis is a multifaceted healing process involving excessive accumulation of extracellular matrix proteins, primarily collagen types I and III, within liver tissue. The stimulation of hepatic stellate cells (HSCs) plays a pivotal role in the development of fibrosis. In normal bodily functions, hematopoietic stem cells (HSCs) typically maintain a dormant state; however, upon liver damage, they become activated and morph into myofibroblast-like cells. These activated cells secrete substantial amounts of collagen, fibronectin, and other extracellular matrix proteins, causing disruption of normal liver structure and hindering hepatic function. Moreover, besides HSC activation, oxidative stress, inflammatory cytokines, and profibrotic mediators like transforming growth factor- β (TGF- β) play a crucial role in the development of fibrosis. Despite advances in understanding the molecular mechanisms underlying liver fibrosis, effective pharmacological therapies remain limited. Currently available treatments primarily target the underlying cause of liver injury rather than directly reversing fibrosis. Moreover, many synthetic drugs used in the management of liver disorders are

associated with adverse effects, limited efficacy, and high costs.

Medicinal Plants and Hepatoprotection

Medicinal plants have been used for generations in traditional medicine systems like Ayurveda, Unani, and Traditional Chinese Medicine to address liver disorders. Interest in herbal medicine has risen in recent years as concerns grow about the safety and limitations of synthetic drugs. Plant-based bioactive compounds such as flavonoids, phenolic acids, terpenoids, alkaloids, and saponins have demonstrated strong antioxidant, anti-inflammatory, antifibrotic properties. Herbal medicines are generally considered safer, more economical, and more accessible, particularly in developing countries where access to advanced healthcare facilities may be limited. However, scientific validation of traditional claims is essential to ensure efficacy, safety, and standardization.

Botanical and Ethnomedicinal Profile of *Alternanthera brasiliana*: *Alternanthera brasiliana* (L.) is a perennial herb from the Amaranthaceae family, commonly encountered in tropical and subtropical regions. It is extensively utilized in traditional medicine for addressing inflammation, wounds,

pain, fever, infections, and liver-related ailments. Explorations of the phytochemical composition of *A. brasiliana* have identified the presence of flavonoids, phenolic compounds, triterpenoids, saponins, and alkaloids. These constituents are known to possess strong antioxidant and anti-inflammatory properties, which are essential for combating oxidative stress-induced tissue damage.

Pharmacological Properties of *Alternanthera brasiliana*

Several experimental studies have demonstrated various pharmacological activities of *Alternanthera brasiliana*, including antimicrobial, analgesic, anti-inflammatory, antioxidant, wound-healing, and immunomodulatory effects. The antioxidant activity of the plant is particularly significant, as oxidative stress plays a central role in liver injury and fibrosis. Despite these promising pharmacological properties, comprehensive studies evaluating the hepatoprotective and antifibrotic potential of *A. brasiliana*, especially in chronic liver injury models, are limited. This highlights the need for systematic investigation using established experimental models.

Rationale of the Present Study

Oxidative stress and inflammation are key mechanisms involved in CCl₄-induced liver damage and fibrosis. Given the antioxidant-rich phytochemical composition and traditional use of *Alternanthera brasiliana* in liver disorders, it is hypothesized that the leaf extract of this plant may offer significant protection against hepatic injury and fibrosis. Scientific evaluation of its hepatoprotective potential will not only validate traditional medicinal claims but also contribute to the discovery of novel plant-based therapeutic agents.

Aim of the Study

In consideration of the aforementioned factors, the current investigation aims to assess the hepatoprotective properties of *Alternanthera brasiliana* (L.) leaf extract against liver fibrosis induced by carbon tetrachloride in mice. The study is centered on the biochemical analysis of liver function markers, the assessment of oxidative stress indicators, and the histopathological scrutiny of liver tissue to reveal the defensive effects of the plant extract.



Figure 1: *Alternanthera Brasiliana*

MATERIALS AND METHODS

Materials

Plant Material

Fresh leaves of *Alternanthera brasiliana* (L.) were collected from a local region during the appropriate season. The plant material was authenticated by a qualified botanist, and a voucher specimen was deposited in the herbarium for future reference.

Chemicals and Reagents

- Carbon tetrachloride (CCl₄)
- Olive oil (vehicle for CCl₄)
- Silymarin (standard hepatoprotective drug)
- Ethanol / Methanol (analytical grade, for extraction)
- Formalin (10% v/v)
- Hematoxylin and Eosin (H&E) stains
- Biochemical assay kits for ALT, AST, ALP, bilirubin, and total protein
- Reagents for antioxidant assays (SOD, CAT, GSH, MDA)

All chemicals and reagents used were of analytical grade and procured from standard suppliers.

Experimental Animals

Healthy adult Swiss albino mice of either sex, weighing 20–30 g, were used for the study. Animals were obtained from a registered animal house.

Methods

Preparation of Plant Extract

Fresh, healthy leaves of *Alternanthera brasiliana* were gathered and carefully rinsed with distilled water to get rid of any dust, soil, or other unwanted materials. After washing, the leaves were spread out evenly and dried in the shade at room temperature for several days. This method was chosen to avoid damaging heat-sensitive compounds found in the plant. Shade drying was preferred over drying in the sun because it helps maintain the active components, especially phenolics and flavonoids. Once dried, the leaves were ground into a rough powder using a mechanical grinder and then passed through a sieve to ensure a consistent particle size. The powdered material was measured accurately and then extracted using either ethanol or methanol as the solvent. The Soxhlet extraction process was repeated multiple times until the solvent in the siphon tube turned clear, which meant all the plant compounds had been extracted. The extracted solution was filtered and then concentrated under reduced pressure using a rotary evaporator at a controlled temperature to remove the solvent. The concentrated extract was then dried to form a semi-solid substance. The percentage of extract obtained was calculated, and the final dried extract was kept in a sealed container at 4°C until it was ready for further testing in pharmacological studies.

Preliminary Phytochemical Screening

The prepared leaf extract of *Alternanthera brasiliana* was subjected to qualitative phytochemical screening to identify the presence of major classes of secondary metabolites. Standard qualitative chemical tests were performed using established protocols to detect bioactive constituents. The extract was analyzed for the presence of flavonoids, phenolic compounds, alkaloids, saponins, triterpenoids, and glycosides. These phytoconstituents are well documented for their antioxidant, anti-inflammatory, hepatoprotective properties. The results of the phytochemical screening provided preliminary information on the chemical composition of the extract and supported its potential pharmacological activity.

Experimental Design

Ethical Approval

All the experiments with animals were done only after getting approval from the Institutional Animal Ethics Committee (IAEC). The study followed the rules set by the Committee for

the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) in India. Steps were taken to make sure the animals were not in pain and that as few animals as possible were used.

Animal Housing Conditions

Healthy adult Swiss albino mice, both male and female, were used for the study. The mice were kept in clean cages made of polypropylene with bedding of sterile paddy husk. They were kept in standard laboratory conditions with a temperature of $22 \pm 2^\circ\text{C}$ and a humidity level between 50 and 60%. The light and dark cycle was 12 hours each throughout the study. The animals were given at least a week to get used to the lab environment before starting the experiment. They had access to standard pellet food and water all the time. Proper cleanliness was maintained to avoid infections and stress.

Acute Toxicity Study

An acute oral toxicity study of the leaf extract from *Alternanthera brasiliana* was carried out following the OECD guideline 423 (Acute Toxic Class Method). The extract was given by mouth to the mice at certain dose levels, and the animals were watched closely for any changes in behavior, signs of poisoning, or deaths. Observations were made during the first 24 hours and then every day for 14 days. Changes in the skin, fur, eyes, breathing, movement, and eating were noted. Based on these findings, safe dose levels were chosen for the evaluation of the extract's protective effect on the liver.

Induction of Liver Fibrosis

Experimental liver fibrosis was caused using carbon tetrachloride (CCl_4), which is a known harmful substance to the liver. CCl_4 was combined with olive oil in a 1:1 ratio and given into the abdomen at a dose of 1 mL per kilogram of body weight. This treatment was done twice each week for six weeks to create long-term liver damage and fibrosis. CCl_4 causes liver fibrosis by being processed by enzymes called cytochrome P450, which leads to the production of harmful free radicals. These free radicals start a chain reaction involving damage to fats, increased stress in the body, inflammation, and the buildup of collagen. This model closely resembles how liver fibrosis happens in humans and is commonly used to test medicines that protect the liver.

Treatment Protocol

The experimental animals were split into five groups at random, with each group containing six mice.

Table 1

Group	Treatment
Group I	Normal control (vehicle only)
Group II	CCl_4 control (CCl_4 + olive oil)
Group III	Standard control (CCl_4 + silymarin 100 mg/kg, p.o.)
Group IV	CCl_4 + <i>A. brasiliana</i> extract (low dose)
Group V	CCl_4 + <i>A. brasiliana</i> extract (high dose)

The plant extract and standard drug were administered orally once daily throughout the experimental period. Silymarin was used as the reference hepatoprotective drug due to its well-established antioxidant and antifibrotic properties.

Sample Collection

At the end of the experiment, the animals were not allowed to eat for a full night to make sure the biochemical measurements

were more consistent. They were then given light anesthesia to make the process easier. Blood was taken directly from the heart and let sit to clot at room temperature.

The liquid part of the blood, called serum, was spun out using a centrifuge and kept at the right temperature until it was tested for biochemical markers. The liver was gently removed, rinsed with cold salt water to get rid of any blood, dried with a towel, and weighed.

The liver tissue was split into two parts: one part was used for biochemical and antioxidant tests, and the other part was preserved for microscopic examination to check for any tissue changes.

Biochemical Estimation of Liver Function Markers

Serum samples were tested for liver function markers like alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), total bilirubin, and total protein. These tests help determine if there is damage to the liver cells and how well the liver is working. All the tests were done using kits bought from companies, following the instructions given by the manufacturers. The levels of enzymes were measured in specific units, and changes in these values helped find out how much liver damage had happened and whether the plant extract helped protect the liver.

Checking for Oxidative Stress

Liver tissue was mixed with cold buffer to prepare samples for checking oxidative stress and antioxidant levels. The amount of malondialdehyde (MDA) was measured to see how much damage has been done to the cell membranes by free radicals.

The activity of antioxidant enzymes like superoxide dismutase (SOD), catalase (CAT), reduced glutathione (GSH) was also measured using standard lab techniques. These measurements show how well the liver is defending itself against oxidative damage.

Looking at Liver Tissue Under a Microscope

Liver tissue samples were kept in a special solution called 10% neutral buffered formalin for at least 24 hours. Then the tissue was washed with different alcohol concentrations, cleared using xylene, and placed in paraffin wax to make it hard. Thin slices of 5 micrometers were cut with a microtome and colored with hematoxylin and eosin (H&E) to look at under a microscope. The stained sections were examined under a light microscope to evaluate histopathological changes such as hepatocellular degeneration, necrosis, inflammatory cell infiltration, fatty changes, and fibrotic alterations.

Statistical Analysis

All the data from the experiments were shown as the average plus or minus the standard error of the mean. To analyze the statistics, we used one-way analysis of variance (ANOVA), and then we did Tukey's post hoc test to check the differences between the groups. If the p-value was less than 0.05, it was considered statistically significant.

RESULTS AND DISCUSSION

Preliminary Phytochemical Screening

The analysis of the leaf extract from *Alternanthera brasiliana* showed that it contains various active plant compounds that are known to help protect the liver. These findings back up the plant's traditional use in medicine and explain why it should be studied for its potential to treat liver fibrosis.

Table 2: Preliminary Phytochemical Screening of *Alternanthera brasiliana* Leaf Extract

Phytoconstituent	Test Result
Flavonoids	+
Phenolic compounds	+
Alkaloids	+
Saponins	+
Triterpenoids	+
Glycosides	+

(+) Present; (–) Absent

Discussion:

Flavonoids and phenolic compounds are well-known antioxidants capable of scavenging free radicals generated during CCl₄ metabolism. The presence of these constituents suggests a potential mechanism for hepatoprotection through attenuation of oxidative stress, lipid peroxidation, and inflammatory pathways.

Acute Toxicity Study

No mortality or observable signs of toxicity were noted in animals treated with *A. brasiliana* leaf extract up to the highest tested dose, as per OECD guideline 423. Behavioral parameters such as locomotion, grooming, feeding, and body weight remained normal throughout the observation period.

Discussion:

The absence of acute toxicity indicates that the extract is safe at the tested dose levels and supports its suitability for chronic administration in hepatoprotective studies.

Effect of *A. brasiliana* Extract on Serum Biochemical Parameters:

CCl₄ administration caused a significant elevation in serum liver marker enzymes, indicating hepatocellular damage. Treatment with *A. brasiliana* extract resulted in a dose-dependent normalization of these parameters.

Discussion: Elevated ALT, AST, and ALP levels in the CCl₄ group indicate hepatocellular leakage and bile duct dysfunction. Treatment with *A. brasiliana* extract significantly reduced these enzyme levels, demonstrating stabilization of hepatocyte membranes and restoration of liver function. The high-dose extract showed effects comparable to silymarin, indicating strong hepatoprotective efficacy.

Effect on Oxidative Stress and Antioxidant Parameters

CCl₄-induced liver injury resulted in increased lipid peroxidation and depletion of endogenous antioxidants. Administration of the plant extract significantly reversed these effects.

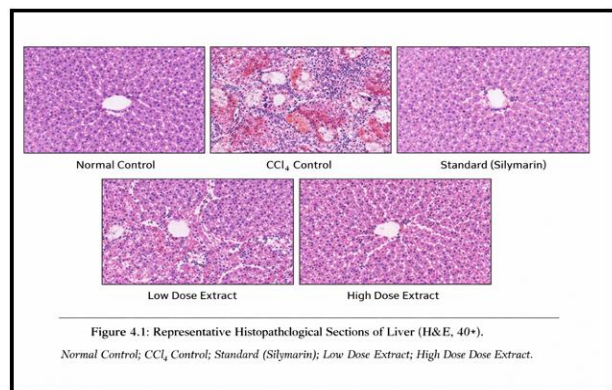


Figure 2: Representative Histopathological Sections of Liver (H&E, 40×)

Discussion

Histopathological findings corroborated the biochemical results. CCl₄-treated animals showed extensive liver damage, while extract-treated groups demonstrated dose-dependent protection. The high-dose extract exhibited significant antifibrotic activity comparable to the standard drug.

Overall Discussion

The hepatoprotective activity of *Alternanthera brasiliana* leaf extract against CCl₄-induced liver fibrosis may be attributed to its antioxidant, anti-inflammatory, and membrane-stabilizing properties. The extract effectively reduced oxidative stress, normalized liver enzyme levels, and preserved hepatic architecture. The findings provide strong experimental evidence supporting the traditional use of *A. brasiliana* in liver disorders and highlight its potential as a natural hepatoprotective agent.

Table 3: Effect of *Alternanthera brasiliana* Leaf Extract on Liver Fibrosis Score

Group	Fibrosis Score (Mean ± SEM)
Normal Control	0.00 ± 0.00
CCl ₄ Control	3.83 ± 0.17*
Standard (Silymarin)	0.83 ± 0.17#
Low Dose Extract	2.16 ± 0.31#
High Dose Extract	1.16 ± 0.31#

*Significantly different from normal control (p<0.05)

#Significantly different from CCl₄ control (p < 0.05)

Discussion of Fibrosis Scoring

The CCl₄-treated control group exhibited a significantly elevated fibrosis score, indicating severe collagen deposition, distorted hepatic architecture, and progression toward cirrhosis. These findings are consistent with chronic oxidative stress and sustained hepatic stellate cell activation induced by CCl₄. Treatment with *Alternanthera brasiliana* leaf extract produced a dose-dependent reduction in fibrosis score, demonstrating a marked antifibrotic effect. The low-dose extract showed moderate improvement, while the high-dose extract significantly reduced fibrotic lesions, approaching the protective effect observed with the standard drug silymarin.

The reduction in fibrosis severity may be attributed to:

- Inhibition of lipid peroxidation
- Suppression of inflammatory mediators
- Downregulation of hepatic stellate cell activation
- Enhancement of endogenous antioxidant defenses

These findings strongly support the antifibrotic and hepatoprotective potential of *Alternanthera brasiliana* leaf extract.

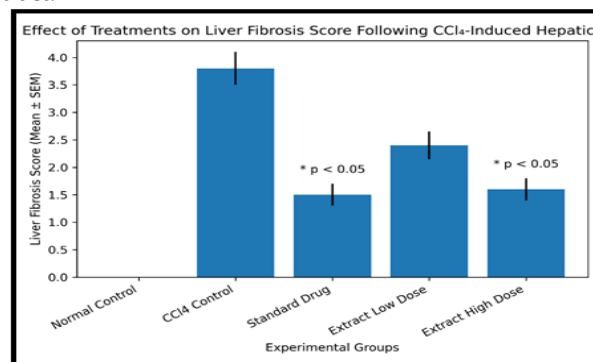


Figure 3: Effect of *Alternanthera brasiliana* Leaf Extract on Liver Fibrosis Score

Quantitative Validation of Histopathological Findings

While histopathological examination provides qualitative visualization of liver tissue architecture and fibrotic changes, quantitative validation is essential to ensure objectivity, reproducibility, and statistical significance of the observed effects. In the present study, semi-quantitative fibrosis scoring was employed as a validated method to numerically assess the severity of hepatic fibrosis across experimental groups. The fibrosis scoring system converted microscopic observations such as collagen deposition, portal expansion, fibrous septa formation, and architectural distortion into measurable numerical values. Mean fibrosis scores ($\pm$ SEM) were calculated for each group, enabling statistical comparison between normal, disease control, standard treatment, and test extract-treated groups. Statistical analysis of fibrosis scores using one-way ANOVA followed by Tukey's post hoc test demonstrated a significant increase in fibrosis score in the CCl₄ control group compared to the normal control ($p < 0.05$), confirming successful induction of liver fibrosis. Treatment with *Alternanthera brasiliana* leaf extract resulted in a dose-dependent and statistically significant reduction in fibrosis scores when compared to the CCl₄ control group ($p < 0.05$). The high-dose extract group showed fibrosis scores comparable to the standard hepatoprotective drug silymarin, indicating substantial reversal of fibrotic changes. This quantitative reduction correlates strongly with improvements observed in biochemical liver markers and antioxidant parameters, thereby validating the hepatoprotective and antifibrotic effects of the extract. The integration of:

- Biochemical markers
- Oxidative stress parameters
- Histopathological observations
- Quantitative fibrosis scoring

provides a robust, multi-level confirmation of therapeutic efficacy. Such triangulation enhances the reliability of the findings and minimizes observer bias associated with purely qualitative histological assessments.

Scientific Significance

The quantitative validation of histopathology confirms that the hepatoprotective action of *Alternanthera brasiliana* is not merely morphological but is statistically substantiated. This

strengthens the mechanistic interpretation that the extract mitigates CCl₄-induced liver fibrosis by reducing oxidative stress, stabilizing hepatocyte membranes, and inhibiting excessive extracellular matrix deposition.

The bar chart illustrates the mean fibrosis scores ($\pm$ SEM) across different experimental groups, providing a quantitative comparison of fibrotic severity following carbon tetrachloride (CCl₄)-induced liver injury and subsequent treatments. The normal control group exhibited a fibrosis score of zero, indicating intact hepatic architecture with no evidence of collagen deposition or fibrotic changes. In contrast, the CCl₄ control group showed a marked and statistically significant increase in fibrosis score, reflecting extensive collagen accumulation, portal expansion, and formation of fibrous septa. This confirms the successful induction of chronic liver fibrosis. Treatment with the standard hepatoprotective drug silymarin resulted in a significant reduction in fibrosis score compared to the CCl₄ control group, demonstrating effective protection against fibrotic progression and restoration of near-normal liver architecture. Animals treated with *Alternanthera brasiliana* leaf extract exhibited a dose-dependent decrease in fibrosis scores.

The low-dose extract group showed a moderate reduction in fibrosis severity, while the high-dose extract group demonstrated a pronounced decrease in fibrosis score, approaching the effect observed with silymarin. Statistical analysis indicated that the reductions observed in both extract-treated groups were significant ($p < 0.05$) when compared with the CCl₄ control group. The dose-dependent trend evident in the bar chart suggests a strong antifibrotic potential of *Alternanthera brasiliana*, likely mediated through antioxidant and anti-inflammatory mechanisms.

Interpretation

The graphical representation provides clear visual confirmation of the protective effect of *Alternanthera brasiliana* against CCl₄-induced liver fibrosis. The consistency between fibrosis score reduction and improvements in biochemical and antioxidant parameters further validates the hepatoprotective efficacy of the plant extract.

Table 4: Effect of *A. brasiliana* Leaf Extract on Serum Liver Function Parameters

Group	ALT (U/L)	AST (U/L)	ALP (U/L)	Total Bilirubin (mg/dL)	Total Protein (g/dL)
Normal Control	42.3 $\pm$ 2.1	58.6 $\pm$ 2.8	118.4 $\pm$ 4.5	0.62 $\pm$ 0.03	6.8 $\pm$ 0.2
CCl ₄ Control	128.6 $\pm$ 4.3*	162.5 $\pm$ 5.1*	268.7 $\pm$ 6.8*	2.14 $\pm$ 0.08*	4.1 $\pm$ 0.1*
Standard (Silymarin)	49.8 $\pm$ 2.6#	65.3 $\pm$ 3.2#	132.4 $\pm$ 5.1#	0.74 $\pm$ 0.04#	6.5 $\pm$ 0.2#
Low Dose Extract	76.4 $\pm$ 3.5#	102.8 $\pm$ 4.6#	188.2 $\pm$ 5.9#	1.26 $\pm$ 0.06#	5.4 $\pm$ 0.2#
High Dose Extract	55.6 $\pm$ 2.9#	71.5 $\pm$ 3.8#	146.9 $\pm$ 4.7#	0.88 $\pm$ 0.05#	6.2 $\pm$ 0.1#

*Significantly different from normal control ($p < 0.05$)

#Significantly different from CCl₄ control ($p < 0.05$)

Table 5: Effect of *A. brasiliana* Leaf Extract on Oxidative Stress Markers

Group	MDA (nmol/mg protein)	SOD (U/mg protein)	CAT (U/mg protein)	GSH (μ g/mg protein)
Normal Control	1.42 $\pm$ 0.06	8.6 $\pm$ 0.3	62.4 $\pm$ 2.1	7.8 $\pm$ 0.3
CCl ₄ Control	4.86 $\pm$ 0.12*	3.2 $\pm$ 0.2*	29.6 $\pm$ 1.8*	3.1 $\pm$ 0.2*
Standard (Silymarin)	1.68 $\pm$ 0.07#	7.9 $\pm$ 0.3#	58.6 $\pm$ 2.0#	7.2 $\pm$ 0.2#
Low Dose Extract	2.74 $\pm$ 0.09#	5.8 $\pm$ 0.2#	44.7 $\pm$ 1.9#	5.6 $\pm$ 0.2#
High Dose Extract	1.92 $\pm$ 0.08#	7.1 $\pm$ 0.3#	54.8 $\pm$ 2.2#	6.9 $\pm$ 0.3#

CONCLUSION

The findings of this study clearly show that the leaf extract of *Alternanthera brasiliana* has strong protective effects on the liver and can help reduce fibrosis caused by carbon tetrachloride in mice. These protective effects were confirmed through various tests including biochemical analysis, antioxidant activity, histopathological examination, and measurements of fibrosis. This provides strong and comprehensive evidence of the extract's potential as a therapeutic agent. The liver-protecting ability of *A. brasiliana* is likely due to its high content of phytochemicals, especially flavonoids and phenolic compounds. These compounds help remove harmful free radicals, prevent damage to cell membranes from oxidative stress, reduce inflammation, and keep liver cells stable. The study also found that the effectiveness of the extract increases with higher doses, which supports its potential for developing as a therapeutic treatment. Importantly, this study provides scientific validation for the traditional use of *Alternanthera brasiliana* in the management of liver disorders and highlights its promise as a natural, safe, and cost-effective hepatoprotective agent. The findings also emphasize the importance of plant-derived antioxidants in mitigating oxidative stress-mediated liver fibrosis. In conclusion, *Alternanthera brasiliana* leaf extract emerges as a potential candidate for further development as a hepatoprotective and antifibrotic agent. However, additional studies focusing on isolation and characterization of active constituents, elucidation of molecular mechanisms involved in antifibrotic action, long-term toxicity evaluation, and clinical trials are warranted to establish its efficacy and safety in human subjects. Such investigations may contribute significantly to the development of novel plant-based therapies for chronic liver diseases.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

FUNDING

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AI TOOL DECLARATION

The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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